SITE CHARACTERIZATION AND MONITORING

SOILS, MINE OPENINGS AND WASTES

DESCRIPTION

Mine openings represent the fundamental environmental impact of AML sites. They include shafts, adits, quarries, strip mines, and open pits. For the purpose of site characterization, these disturbances must be mapped.

Mine wastes (overburden, spoil, underground waste rock, stockpiles, tailings) often disturb a larger area and have a greater environmental impact than the mine openings. The chemical and physical character of these wastes are key factors in determining the success of remediation.

Soils serve as a chemical and physical buffer between the mine wastes and other environmental media -- water, land, air, wildlife.

Site characterization techniques are basically the same for soil and mine wastes.

Cost: $2,000 to $500,000 per project.

DATA REQUIREMENTS 1/

* Topographic site map of mine disturbances.

* Soil map of mine wastes and surrounding soils.

  ** Minimum scale: 1 in. to 100 - 700 ft depending on size of project.

  ** Level of detail: Soil units from 0.5 to 5 acres. Show sample location.

  ** Sample density and depth:

     For soils, 1 to 6 profiles per mapped soil unit depending on chemical and physical variability. Depth up to 7 ft or bedrock whichever comes first.

     For mine wastes, 1 auger hole per 40 acres, 3 minimum. Sample entire thickness on 2 - 10 ft intervals depending on chemical and physical variability.

  ** Local Soil Conservation Service office provides assistance with soil surveys and soil identification.

* Volume of mine wastes and available soil, normally estimated with isopach maps.

* Geologic map and cross sections.

* Chemical analysis of mine wastes and soils.

Table VI lists typical chemical analyses, and also provides criteria for unsuitable material. Unsuitable material must be treated, buried, and not used within reach of plant uptake. Test also for trace metals. Split samples and send 10% of duplicates to another lab for quality control. Check on State and local requirements. Heavy metal pollution found at some mine sites:

TABLE VI
TYPICAL CRITERIA FOR UNSUITABLE MINE WASTES AND SOILS

Parameter	Criteria
pH acid	< 6.0
pH alkaline	> 8.5
Electrical Conductivity (millimhos/cm)	> 4.0 - 8.0
Texture	Excessively clayey, silty, or sandy
Moisture Saturation	< 25% or > 85%
Sodium Adsorption Ratio	> 12 - 15 depending on texture
Exchangeable Sodium	> 15% - 18% depending on texture
Boron	> 5.0 ppm
Selenium	> 0.1 ppm
Acid-Base Potential	< -5 - 0 tons $CaCO_3$ per 1,000 tons
Mo	> 0.5 - 1.0 ppm
Organic Carbon	> 10%

REFERENCE; (USOTA, 1986, p. 190)

** Risks to public health include cations of arsenic, cadmium, mercury, lead, nickle, manganese, and molybdenum. Cyanide is a highly toxic chemical used for extracting precious metals. Fortunately it is usually short lived; however, it can remain in dry, alkaline processing wastes not exposed to air and sunlight.

** Risks to aquatic life include copper.

** Risks to plants include iron, aluminum, and zinc when they are in high concentrations.

** At mill sites, there will always be heavy metals present.

* Soil nutrients:

  Organic Matter

  Macro Nutrients

Nitrogen (N)	Phosphorus (P)
Potassium (K)	Calcium (Ca)
Magnesium (Mg)	Sulfur (S)

  Micro Nutrients

Boron (B)	Copper (Cu)
Manganese (Mn)	Zinc (Zn)
Iron (Fe)	Molybdenum (Mo)
Chlorine (Cl)	

* Physical properties of mine wastes and soils including bulk density, texture, and size distribution.

* Evidence and possible extent of mine fires either underground or in smoldering waste dumps.

* Site climate including precipitation and temperature.

* Research State mine reclamation statutes for additional requirements.

MONITORING

Some mine closures have deteriorated to a condition that is more hazardous in regard to public safety than before the mine was closed. This deterioration results from the temporary nature of the closure, natural weathering, and vandalism. All abandoned mines including those restored and those not restored should be monitored regularly and their condition documented.

The monitoring schedule depends on:

* Environmental conditions.

* Type of closure.

* Type and number of visitors.

The following scenarios provide extremes in monitoring from which local guidance can be determined.

* Monitor weekly or daily heavily visited AML sites with numerous potential hazards.

* Monitor once every 3 to 5 yr remote, permanently backfilled sites.

* Monitor environmental conditions after winter and large storms.

* Use the Maintenance Management System to track monitoring and maintenance.

REFERENCE: This section paraphrased from USOTA, 1986, p.126.

MINE DRAINAGE

DESCRIPTION

Mine drainage problems include effluents of acid or alkaline waters and/or erosion and subsequent deposition of sediment in surface water. The adverse impacts of mine drainage relate to the degradation of water quality, which may affect wildlife habitat, park resources, water supply, and flooding.

Cost: $15,000 to $100,000 per project.

PROBLEM IDENTIFICATION

Acidic Sites

A fail-safe indicator of acidic conditions is the presence of ferric hydroxide precipitate on the bottom of a streambed. Typically, this precipitate has an orange color, but the color may vary from yellow-red through purple. The precipitate is known as "yellow-boy" in the mining industry. Other indicators include:

* Acid conditions in either mine wastes, surrounding soils, or surface water indicate acid mine drainage.

* Acidic stream water may be crystal clear, don't be fooled by water color.

* Acidic mine wastes and soils are bare of vegetation (except for an occasional hardy individual), and free of insects and small mammals.

* Sulphurous compounds in mine wastes often smell.

* Presence of pyrite (metallic, gold colored specs).

Alkaline Sites

A tell-tale sign of alkaline sites is noticeable accumulations of salts (white to dark color), and large surface cracks. Other indicators include:

* Alkaline soils usually support poor vegetation and the area may be entirely devoid of plants.

* Often alkaline sites are small, appearing nearly circular in shape, and easily distinguished from surrounding vegetated areas.

DATA REQUIREMENTS

Surface Water Studies

* Detailed location map of all surface water features.

* Streamflow quantity data including seasonal and annual variations, floods, and low flows.

  ** Perennial and intermittent streams should have continuous recording gages.

  ** Ephemeral streams should have crest gages read monthly and immediately on significant runoff events such as snow melt or storms.

* Streamflow quality data including both physical and chemical characteristics, and the relationship between mine discharge and quality. Quality parameters include:

  ** Field analysis: pH, EC, temperature, DO.

  ** Laboratory analysis: TDS, TSS, oil and grease, SAR, HCO_3, Ca, Cl, Mg, NH_3, NO_3, NO_2, PO_4, Na, SO_4, Al, As, B, Ba, Cd, Cr, Cu, F, Fe, K, Pb, Mn, Hg, Mo, Ni, Se, Zn.

  ** Sample perennial streams monthly or frequently enough to characterize quality.

  ** Sample intermittent and ephemeral streams twice a year and during significant runoff events such as snowmelt or storms.

* Description of climate including mean annual precipitation, precipitation frequency and duration relationships, and seasonal and annual variations in precipitation.

* Description of water use.

Groundwater Studies

* Map of all surface expressions of groundwater including mine drainage and influx, aquifer recharge and discharge, existing wells, and springs.

* Geologic data, maps, and cross-sections that show confining layers, hydrologic barriers and boundaries, faults, and folds.

* On affected aquifers:

  ** Static water level data including seasonal variations.

  ** Potentiometric surface maps.

  ** Water quality data including seasonal and annual variations. Refer to list of quality parameters under Surface Water Studies.

  ** Pump tests to determine permeability, transmissivity, and storage coefficients; effects of hydrologic barriers and boundaries; interaction between aquifers; and interactions between groundwater and surface water systems.

* Geochemical data on the mine wastes for use in predicting post remediation water quality.

MONITORING

Monitor stream gages and wells on the same schedule as above until revegetation has been successful. After successful revegetation, taper off monitoring over a two or three year period.

REFERENCES: This section paraphrased from USOTA, 1986, p. 139; (USFS, no date, p. 27 & 28.

VEGETATION

DESCRIPTION

Mining activity results in destruction of vegetation in the disturbed areas. While some AML sites have revegetated naturally, many remain barren from the unsuitable characteristics of the growing environment.

The purpose in characterizing site vegetation is to identify areas requiring remediation, and identify vegetation appropriate for use in remediation.

Cost: $2,000 to $30,000 per project.

DATA REQUIREMENTS

* Maps showing existing vegetation types on a scale of 1 in. to 400 - 700 ft.

* Cover data both relative and absolute. Sampled by quadrat, line intercept, or point intercept.

  Absolute cover is the actual percentage of ground shielded by each plant species, and may be greater than 100% where plant canopies overlap.

  Relative cover is the percentage of the total vegetative cover contributed by each species and must total 100%.

* Spatial and local density of woody plants by micro-environmental areas. Sampling by quadrats, belt transects, and plotless samples.

* Vegetation diversity by:

  ** Species.

  ** Lifeform (particular morphologic category of a species such as tree, shrub, grass, or subdivisions of these categories).

  * Seasonality (time of year when a plant accomplishes most of its growth).

MONITORING

Monitoring determines the success of revegetation, and the need for remedial measures such as supplemental watering, additional seeding or transplanting, and weeding of unwanted species. Trends should be measured with statistically valid sampling techniques and photographic records.

Monitoring should occur seasonally until the vegetation is capable of self-regeneration and plant succession equal to the natural vegetation of the area. Continue monitoring for 10 yr in areas with rainfall less than 25 in. per yr and 5 yr in areas with rainfall greater than 25 in. per yr.

REFERENCES: This section paraphrased from USOTA, 1986, p. 152; Thorne, 1987, p. 13.

WILDLIFE

DESCRIPTION

Most AML sites are small and have little impact on wildlife. Even the larger sites have unpredictable impacts on wildlife because many species are mobile and have some capacity for adaptation. Indeed some endangered species adopt AML sites for their habitat including bats, ring tail cats, and spotted owls. Wildlife studies are required to ensure that remediation sustains wildlife and protects endangered species.

Cost: $3,000 to $25,000 per project.

DATA REQUIREMENTS

* Species and their seasonal occurrence.
* Relative population densities of ecologically important species.
* Maps showing habitat classification and delineation including special habitat features such as use of AML sites.
* Minimum one year of data collection.
* Studies cover site plus a 0.25 to 2 mi buffer zone.
* Refer to park guidance on acceptable data collection techniques.

MONITORING

Wildlife monitoring uses the same techniques as the other baseline studies, but generally tend to be much less intense. Refer to park guidance.

REFERENCE: This section paraphrased from USOTA, 1986, p. 159.

HISTORICAL SURVEYS

DESCRIPTION

Historical surveys identify cultural resources that contribute to the character of an area or illustrate the area's history.

Cost: $1,000 to $20,000 per project.

AUTHORITY

* Sections 106 and 110 of the National Historic Preservation Act.

* Secretary of the Interior's Standards and Guidelines for Historic Preservation.

* NPS-28.

DATA REQUIREMENTS

* Literature search.

  ** Site location and description information such as cultural and historic reports.

  ** Current and historic maps.

  ** Bureau of Land Management and county court house mining claim files, and State mining case files.

  ** Historical photographs, newspapers, Federal and State publications, location and legal notices.

  ** Interview long-time residents of the area.

* Inventory of cultural resources including:

  ** Significant structures (buildings, mine machinery, mill plants, housing, foundations).

  ** Building materials.

  ** Artifacts.

  ** Roads.

* Detailed condition of features.

* Describe impact of mine closure and remediation alternatives on historical and cultural resources.

* Identify any approved plans for historic preservation.

* Maps:

  ** Location.

  ** Site.

  ** Features.

* Photographic record.

MONITORING

If the site is preserved, use the Maintenance Management System to track monitoring and maintenance.

REFERENCES: This section paraphrased from Barker et al, 1990; NPS, 1990.